FINAL REPORT
February 2010

Utah Department of Agriculture and Food

Cooperative Agreement No. 12-25-G-0535
Termination Date: December 31, 2009

As required by the Specialty Crop Block Grant Program, the Utah Department of Agriculture and Food (UDAF) is providing the "**Final Report**" for Cooperative Agreement No. 12-25-G-0535. Nine of the ten projects approved in the 2007 Grant were completed the first year and provided a "Final Report" which were included in the 2008 and 2009 Annual Reports.

One of the projects approved for $9,900 titled "Improved Weed Management for Increased Utah Dry Bulb Onion Production" was designed to test various herbicides in Utah soils and conditions to determine effectiveness. Funds for the project weren't available until June 2007, too late to initiate the project. Therefore, the project began in the spring of 2008 and was to be completed by year-end. An extension was requested and granted with a new termination date of 12-31-08.

During the summer of 2008 one of the test plots was flooded from an adjacent wheat field significantly enough to impact onion growth and confound any effects of the herbicide treatments. With over $4,000 left in the project grant, it was felt that sufficient funding remained to examine selected treatments in 2009 based on the results of 2008. The additional year of data will be useful in establishing both the safety and utility of the newly approved herbicide treatments for use in Utah onion production. An extension was approved to 12-31-09. Annual Reports were provided for this project in 2008 and 2009.

The Final Reports of the other 9 projects previously approved are duplicated and included in this report along with the Final Report for Improved Weed Management in Utah Onions in the following order:

A. Improved Weed Management for Increased Utah Dry Bulb Onion Production
B. Emery County Fruit Tree Demonstration
C. Carbon County Farmer's Market Establishment
D. Utah Nut Tree Rootstock and Cultivar Trial
E. Principals of Food Processing, Hygiene, Sanitation and Food Plant Inspection
F. Improving Orchard Irrigation
G. Codling Moth Monitoring and Cherry Fruit Fly Trapping
H. Survey of Erwinia amylovora (Ea) Bacterial Isolates
I. Evaluating the Native Shrub Eriogonum corymbosum as a Nursery Crop and for use in Low Water Use Utah Landscapes
J. Utah's Native Flora

A Standard Form 269A, Financial Status Report, is provided along with this report which is a summation of the financial performance of all projects. A breakdown of grant money provided for each project along with recipient outlays and total outlays for each project are as follows:

Summary of Financial Performance of all Projects

Project Title	Grant Amt	Recipient Outlays	Total Outlays
Onion Weed Management	$ 9,900	$ 5,000	$14,900
Emery Fruit Tree Project	1,300	1,768	3,068
Carbon Farmers Market	2,000	500	2,500
Nut Tree Rootstock Trial	18,000	18,500	36,500
Food Processing Audits	6,000	1,742	7,742
Orchard Irrigation	8,000	11,000	19,000
Codling Moth	9,000	6,500	15,500
Bacterial Isolates	6,760	4,490	11,250
Native Shrub Eriogonum	12,650	11,112	23,762
Utah's Native Flora	25,000	31,536	56,536
UDAF Administrative Expenses	4,525	3,676	8,201
Totals	$103,135	$95,824	$198,959

Contact Person: Jed Christenson, Director of Marketing and Development, UDAF
Office Phone: 801-538-7108 E-mail: jedchristenson@utah.gov

Final Report

A. Improved Weed Management for Increased Utah Dry Bulb Onion Production

Outline of the issue, problem, interest, or need for the project: Weed competition reduces onion yield and quality. Herbicides currently registered for use in onions are limited and some weeds are not controlled well with the available products. The Pest Management Strategic Plan completed in 2004 for Dry Bulb Storage Onions in Colorado, Idaho, Oregon, Utah, and Washington listed the identification and registration of new herbicides for use in onion production as one of the most critical needs in onion pest management. Several new herbicides had been registered for use in onions, but little data was available to Utah growers on efficacy and crop safety with these new herbicides.

Approach: The approach to the problem included conducting research field trials and providing the results to the Utah onion growing industry.

Goals Achieved: Field trials were conducted on onion grower fields to test and demonstrate the effectiveness of various herbicide treatment programs including standard herbicides and new herbicides registered in the past few years. Trials were conducted under statistically valid designs with appropriate replications and trials were repeated in 2008 and 2009 to account for

potential environmental influences. Data were collected on crop injury, weed efficacy, and onion yield. Economic impact of the herbicide treatments was evaluated by calculating net returns based on onion yields and herbicide treatment cost. Research results were provided to onion producers through presentation given at their annual meetings in 2008 and 2009 and plots were shown at field tours in the summers of 2008 and 2009.

Results, conclusions, and lessons learned: Trial results clearly demonstrated the necessity of utilizing both soil-active herbicides and postemergence herbicides together in a weed control program to maximize weed control and onion yields. The data also show that some combinations can cause significant onion injury and result in reduced onion yields. Trial results suggest that utilizing Nortron, one of the newer herbicides, in postemergence herbicide mixtures could possibly maintain effective weed control while reducing onion injury. While adding Nortron to herbicide combinations significantly increased the herbicide costs, in most cases the resulting yield increase would easily offset the added cost. The information provided by this project gives Utah onion producers more options for controlling weeds and potential for improving onion yields.

Long-Term Outcome Measures: We have accomplished the long term objectives of providing the growers with the information from the research trials. With this information, the producers have the potential to increase the profitability of their production systems. To this point, growers have not chosen to pursue a registration for preemergence use of Prowl in onion. However, there is now data to support this registration if they decide to proceed. With the project now completed, it will take some time to see if growers adopt Nortron use for weed control in onion production in Utah. This can be tracked by future Nortron sales in Utah. Data from this research is currently being drafted into an article for submission to a refereed journal.

Additional Information:
None

Contact:

Corey V. Ransom
Weed Scientist
Utah State University
(435) 797-2242
corey.ransom@usu.edu

B. Emery County Fruit Tree Demonstration

Outline of the issue, problem, interest, or need for the project: This project was done to create a model for a specialty fruit crop industry in Emery County, Utah. There were successful fruit operations in the county that spanned over 100 years, but they have been phased out over the past few years.

Approach: Plant different varieties of fruit crops on a small scale that are early producing to take advantage of an early market opportunity, and specifically plant some cherries that have later flowering dates that will survive late frosts in the area.

Goals Achieved:
Goal 1. Test and establish "late blooming" but "early season" fruit varieties to create first-to-market opportunities for peaches, cherries, and grapes.
Achievement: Each of the fruits were planted, pears and plums were also added to the project.

Goal 2. Focus marketing at existing community celebrations rather than roadside stands.
Achievement: This will be realized in future years, the young trees have just started bearing fruit this year.

Goal 3. Partner with USU Extension to test state of the art orchard micro-irrigation.
Achievement: Local Extension agent helped to design and implement irrigation system.

Goal 4. Utilize Colorado River Salinity Forum funding of pressurized irrigation systems.
Achievement: This project was moved to phase 3 of the local Huntington/Cleveland Irrigation project, so the pressurized irrigation system will be realized within the next 2 years.

Goal 5. Partner with Castleland RC&D Council to provide administrative support and monitoring.
Achievement: Castleland RC&D Council approved this project as part of their Regional Ag Marketing. They have provided administrative support and reported on results of the project.

Results, conclusions and lessons learned:

- The late arrival (late June) of the "late blooming" bare-root cherry trees caused increased mortality during the first year: 38 cherry trees were planted, 12 are alive. The first harvest on the young trees was realized this year.
- 20 peach trees were planted, 8 were lost. The 12 remaining trees have thrived and are producing a small amount of fruit for the first time this year.
- 15 grapes were planted.
- 2 plum trees were planted, both have survived.
- 5 pear trees were planted, 3 have survived.

For the soils and climate of the area, the best crops are Peaches, Apples, and Pears—even the late blooming cherries haven't proven effective. Bare root trees must be planted in the *early* spring in order to survive the "transplant shock" in the area.

Long-Term Outcome Measures: The delay of the pressurized irrigation system made the implementation of the micro-irrigation system difficult, but it was still utilized with modifications. The marketing aspects will be tested as soon as the trees bear greater amounts of fruit.

Additional Information: Utah State University Extension website provides additional information on some of the specialty crops.

Contacts: Owner/Operator: Michael B. McCandless: 90 East 500 South P.O. Box 561, Huntington, Utah 84528. Phone (435) 749-1368 Email: mbm@etv.net
Casteland RC&D Coordinator: Wayne Urie: 1120 N. Des Bee Dove Road P.O. Box 1114, Castledale, UT 84513. Phone (435) 381-2300 ext. 103 Email: Wayne.Urie@ut.usda.gov

C. Carbon County Farmer's Market Establishment

Outline of the issue, problem, interest or need for the project: Several small Farmer's Markets have been tried in the small communities of Castle Country with little or no advertising. They have all failed. Several local gardeners and small producers decided to try to establish a market in Price—the population hub of the area. The grant was needed to advertise throughout the communities.

Approach: Radio and newspaper advertising was purchased throughout the market season and signs were purchased for placement at strategic places in the community.

Goals achieved: The advertising was extremely helpful in informing the community of the market. Many weeks the produce sold out so customers started coming early for better selection. The best estimate for gross sales for first season was $8,000 to $9,000, at or slightly above the expected measurable outcome of $8,000. It was expected that on average 200 customers would visit the market per week. The actual average was 150 customers per week.

Results, conclusion and lessons learned: The response from the community was very positive with a great desire to see the market continue in subsequent years. A variety of produce was provided. Future emphasis will be to have advertising and announcements indicate the main produce that will be available each week. The hope is to start the market earlier in the season, depending on spring weather conditions.

Long-term outcome measures: With the positive response from the community, producers are excited to have the market become a permanent event in the community. City leaders have approached market vendors about having additional markets at different events to help add variety and interest to community activities.

Additional information: Currently there is no additional information such as publications or a web presence for the market.

Contact:

Ron Patterson, 435-636-3235, Ronald.patterson@usu.edu

D. Utah Nut Tree Rootstock and Cultivar Trial

Outline of the issue, problem, interest or need for the project: Currently there are few research-based recommendations of nut tree varieties for the state of Utah and the Intermountain West even though many nut trees are growing in the region. The lack of this research is a limiting factor for potential growers and groups or individuals promoting fruit and nut tree planting for food production, the environment and aesthetics. For example: TreeUtah, Inc., a not-for-profit organization that funds and encourages community tree plantings, is planting an edible park and wants to include the best nut tree varieties, but research based recommendations are limited.

Nuts are a highly nutritious, high-protein, storable and sustainable food crop that can thrive in Utah and the Intermountain West. Research efforts are required to identify and develop the varieties of nut tree that are pest resistant, cold and drought tolerant, and produce a high yield of nutritious food. In addition, tree crops contribute to building, enhancing, and maintaining soil structure and fertility. Their large, deep perennial root system mines nutrients and brings them near the surface making them available to grasses, forbs and shrubs. Additionally they reduce nutrient and pesticide leaching, and they avoid short-term droughts that harm annual and many other perennial crops. Tree crops can be planted on steep or sloping lands or fragile soils not suitable for the sustainable production of cultivated annual crops thereby dramatically increasing food production and the harvesting of carbon dioxide on this vast land resource and the employment of millions throughout the world.

Approach: IPPFBE combined the funds provided by the Utah specialty crop grant ($18,000) with its internal endowment fund to support the planting of 7,593 trees in 2007 in eight different field test locations in Northern Utah, one test location in Southwestern Wyoming, and one test location in Southeastern Idaho. The trees planted in 2007 comprised thirty-four species and 233 different varieties and accessions. The trees were obtained from 41 different sources.

Goals achieved: Table 1 lists the species and the number of trees from each species. Table 2 lists the ten different test site locations and number of trees planted in each location. Three of the test sites are located in Richmond, Utah (Bryan Dayton Yard, Ken and Ramona Turner Yard, and Reed and Donna Funk Yard). Four of the test sites are located on farms East of US 91 between Smithfield and Richmond, Utah (David and Tamara Funk Farm, David and Tamara Funk Orchard, Springhill Ranch North enclosure, and Springhill Ranch South enclosure). These four test sites have been leased to IPPFBE for a period of thirty years (January 1, 2006, to December 31, 2035). A total of 320 acres of Springhill Ranch property and ten acres of the farm owned by David and Tamara Funk are leased to IPPFBE.

Another test site is located on a forty-acre field of prime agricultural land near Dayton, Idaho, and this test site plus two other test sites near Dayton, Idaho, have been leased to IPPFBE for the same thirty-year period.

Table 1 Species of trees planted by IPPFBE in 2007

Species	#Trees	Species	#Trees
Almond	21	Heartnut	187
Almond hybrids	189	Japanese Chestnut hybrids	46
American Chestnut	11	Mt.Atlas Pistachio	120
American Hazelnut	1	Northern California Black Walnut	15
Apricot	64	Northern California Black Walnut hybrid	1
Arizona Black Walnut	10	Oak	1
Black Walnut	596	Peach	38
Black Walnut hybrid	90	Pecan	2,605
Butternut	1	Persian Walnut	2,639
California Black Walnut	4	Pistachio Nut	641
Chinese Chestnut	73	Plum	2
Chinese Chestnut hybrid	31	Sea-buckthorn	10
Chinese Pistachio	10	Sweet Cherry	3
Chinese x (American x Japanese Chestnut)	54	Texas Black Walnut	16
European Chestnut Hybrid	1	Turpentine Tree	91
European Hazelnut	11	Total	7,593
European x American Chestnut	11		

Table 2 Number of Trees Planted at Different IPPFBE Test Sites in 2007

Location	Total
Bryan Dayton Yard	519
David & Tamara Funk Farm	242
Dayton, Idaho - North	5,686
Ken & Ramona Turner Yard	356
David & Tamara Funk Orchard	12
Reed & Donna Funk Yard	10
Springhill Ranch North	156
Springhill Ranch South	31
Cody, Wyoming - Ranch	12
Zollingers Farm	569
Total	7,593

Table 3 lists the forty-one different sources of the tree germplasm planted by IPPFBE in 2007.

Table 3 Sources of Tree Germplasm Planted by IPPFBE in 2007

Source	# Trees	Source	# Trees	Source	# Trees
Anderson	1	Fulbright	81	Nemaguard	3
AZ nursery	54	Goffreda	11	One Green World	9
AZ Pistachio	59	Grauke	60	OSU	1
Bill Reid	2,028	Greg Miller	38	Paramount	3
Bryan	9	Grimo	485	Pat	1
C&O	6	Hadfield	68	R117 Krymsk	1
C&O seedling	3	IPPFBE	249	Rutgers	356
Cadaman	8	J7 North	54	Thorson	150
Canning	11	J7 Tree #4	2	Troy Pabst	442
Citation	8	John Gordon	106	UC Davis	2,092
Cobb	1	Lamunyon	2	USU	22
Controller #5	3	LJ Grauke	312	Not Specified	144
Dabb	528	Lovell	5	Grand Total	7,593
DBP	7	Monroe	165		
Finlinson	3	Nebraska	2		

Table 4 listed the different methods used by IPPFBE to propagate trees in 2007.

Table 4 Propagation Methods Used by IPPFBE in 2007

Propagation Method	# Trees
Direct Seeded	5,968
Transplanted from IPPFBE Greenhouse	1,332
Layered	7
Transplanted from commercial nursuries	260
Field Grafted	17
Not specified	9
Grand Total	7,593

Results, conclusions, and lessons learned: The scientific evaluation of tree crops in the Intermountain West is a long term, ongoing project with IPPFBE. The following information highlights the results, conclusions, and lessons learned from the 2007 Utah Nut Tree Rootstock and Cultivar Trial supported by the Utah State Department of Agriculture:

Apricots: A number of very promising achievements and opportunities have been observed in our apricot (*Prunus armeniaca* L.) improvement and evaluation program at Dayton, Idaho, and Thatcher, Utah. They include:

1. Selections with improved cold tolerance during flowering and early fruit development.
2. Accessions with improved resistance to lime-induced iron chlorosis
3. A substantial increase in the length of the fruit ripening and the associated marketing period from very early to late fruit maturity
4. Improved and a high degree of variability in flavor
5. Better tolerance of saline irrigation water
6. Improved root stock performance
7. Sweet, nutritious edible pits (nuts)
8. Higher sugar content

Many of these characteristics exceed those of any currently available variety. These improved traits will be combined and incorporated into new variety releases.

Walnuts: Considerable effort has been expended on black walnuts (*Juglans nigra* L.), a native American species, and Persian (English) walnuts (*Juglans regia* L.). Primary emphasis has been directed to improving nutritious food production, but significant attention is also given to timber and biomass production and the increased harvesting of carbon dioxide. Much of the best available black walnut germplasm was obtained from private and public breeders in Iowa, Nebraska, Missouri, Indiana, New York, Minnesota, Oklahoma, Kentucky, Ohio, and Pennsylvania. Considerable effort was made to select seed nuts and scion wood from old trees planted by early pioneers settling Utah and the Intermountain West. Most of the Persian walnut germplasm was obtained from breeding programs, germplasm repositories and native forests of Central Asia, mainly Kyrgyzstan and Uzbekistan. Seed nuts were inspected, fumigated and brought to the USA through proper plant quarantine procedures. Some seedlings have demonstrated considerable potential for breeding improved varieties for Utah, the Intermountain

West and other temperate semi-arid regions of the world. Some of the most precocious selections have the ability to produce nuts after only two or three years from planting. Others selections produced very large nuts, and a few have a very delicious sweet taste. Black x Persian F1 hybrids show considerable hybrid vigor and appear to be capable of producing high quality fast growing timber.

A new and serious threat to black walnuts and likely other walnut species is occurring and has been identified in New Mexico, Colorado, Oregon, and Utah. It has been killing both seedlings and mature black walnut trees in Provo, Salt Lake City, and Cache Valley (private communication and personal observation).

Dr. Ned Tisserate at Colorado State University discovered that the walnut decline is caused by a combination of the walnut twig beetle *(Pityophthorus juglandis)* and a fungal pathogen *(Geosmithia)* [Ned.Tisserat@ColoState.EDU]. Observations at our most highly infected site (Nursery leased from Ken and Ramona Turner at 72 West Main Street, Richmond, UT) indicate various levels of quantitative genetic resistance in both black and Persian walnuts. We are hopeful of finding high levels of stable genetic resistance in both species and in other cross-compatible walnuts. This would be extremely valuable, especially if this malady spreads to the commercial walnut production areas of California or the walnuts in the forests of Eastern USA, Canada, Europe or Asia.

Hazelnuts: Hazelnut (*Corylus spp.*) shows high potential for substantial achievement through evaluation, research and breeding. There is a tremendous amount of genetic diversity of cross-compatible species in Europe, North America, and Asia. We have developed close collaboration with scientists and breeders at Rutgers, Oregon State University, and the University of Nebraska. We have many germplasm sources with high levels of both qualitative and quantitative resistance to the devastating and economically important Eastern Filbert blight disease. We have also obtained genetic material for very attractive ornamental types with attractive colorful leaves, adequate cold tolerance, tasty nutritious nuts, a bush-type growth habit, and tolerances of multiple soil types and climatic conditions.

Pistachio: We have initiated a program to collect, evaluate, and develop improved Pistachio (*Pistacia vera*) varieties for Utah and the Intermountain West. Soil and climate conditions at our Thatcher, Utah, test site are similar to those of native stands and at breeding stations in the Central Asian countries of Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan. Pistachios could be produced on sites where the Colorado Pinion (*Pinus edulis* Engelm) and the single-leafed pinion (Pinus monophylla Torr. & Frem.) are adapted. Two of our most-advanced female plants are currently producing large, attractive clusters of flowers. A journal article is in preparation on under-exploited germplasm of pistachio ecotypes from Central Asia. Selections from Uzbekistan are showing considerable promise on a dry hillside west of Thatcher, Utah.

Long-term outcome measures: In addition to the ten tree breeding field sites listed in table 2, in 2008 IPPFBE is negotiating a lease for parts of a farm (The Petersen Ponderosa) located west of Thatcher, Box Elder County, Utah, owned by the Board of Director member Carol Jean Petersen and her husband, Brian Petersen. The land immediately west of Thatcher is generally east-facing gentle slopes with good quality well-drained soils and can be irrigated with the irrigation water

obtained from the Bear River. The higher elevation land as the farm continues towards Thatcher Peak is sloping dry farm and rangeland with well-drained, gravelly soil. Irrigation water is available for this land from a moderately salty well. IPPFBE's sources of apricot and pistachio germplasm are performing well on the leased land in Thatcher.

There is an increasing need for worldwide food security, and local food production significantly reduces transportation cost and fuel usage. Perennial trees and shrubs that produce nuts and fruits will allow Utah and other parts of the Intermountain West to grow larger quantities of nutritious food. Biomass production from perennial plants will help our nation reduce its dependence on foreign petroleum.

Additional information:

Website: http://ippfbe.org/

Many papers and presentations describing IPPFBE research and associated activities can be downloaded from the above website.

IPPFBE officers and directors generated the following publications and presentations in 2007:

Refereed Journal Publication

1. Molnar, T.J., S.A. Mehlenbacher, D.E. Zaurov, and J.C. Goffreda. 2007. Survey of hazelnut germplasm from Russia and Crimea for response to eastern filbert blight. *HortScience* 42:51-56.

Non-refereed publications:

1. Molnar, T. J., C. R. Funk, J. Goffreda, E. Orton, J. Heckman, B. Clarke, and J. White. 2007. "Genetic Improvement of Underutilized Perennial Crop Plants," *AD-421 Progress Report,* U.S. Department of Agriculture, January 27, 2007.

2. S.N. Baxer, J.A. Crouch, R.F. Sullivan, B.I. Hillman, T.J. Molnar, and C.R. Funk. 2006. Investigating genetic diversity of Anisogramma anomala, causal agent of eastern filbert blight. *Abstracts of the North East Division American Phytopathological Society Meeting*. Posted online May 2, 2007

3. Molnar, T.J., S.N. Baxer. G. Zhang, and C.R. Funk. 2007. Role of turf grasses and other landscape plants in reducing global warming and our addiction to fossil fuels. p. 44. *Proceedings of the Sixteenth Annual Rutgers Turf grass Symposium.* Center for Turf grass Science. School of Environmental and Biological Sciences. Rutgers University.

4. Capik, J. and T.J. Molnar. 2007. Chip bud layering: an easy way to produce rooted layers of hazelnuts. *The Nutshell, quarterly newsletter of the Northern Nut Growers Association*. Vol. 61:15-18

IPPFBE officers and directors delivered ten Seminar Presentations during 2007

Twenty United States Plant Variety Protection Certificates were issued to IPPFBE officers and directors during 2007

Contact:

Dr. Reed Funk
President and Chairman of the Board of IPPFBE
711 South State Street
Richmond, UT 84333-1570
435-258-2203
Email Address: cfunk@san.rr.com
(Note: Email address is for Clarence Funk, Secretary/Treasurer of IPPFBE)

E. Principles of Food Processing Safety, Hygiene, Sanitation and Food Plant Inspection

Outline of the issue, problem, interest or need for the project: Since most food purchasers now require third party audits of their food suppliers, Payson Fruit Growers realized that the Tart Cherry Industry in Utah needed further training in specialized areas such as HACCP, GMP's and Food Safety to insure to our customer that we have in place policies and practices that insure a safe, nutritious and protected food supply. We found that the best training could be obtained from AIB Food Safety and Security Education.

Approach: In May 2007 AIB presented a 2 – day training seminar that concentrated on providing instruction in HACCP, Food Safety and other areas needed.

In November 2007, Carl Schuchardt, Technical Services Director of Oceana Foods in Michigan, provided one week of specialized training and inspections for local fruit processors including McMullins Orchards and both Payson Fruit Growers processing plants.

Goals achieved: Management, numerous full time and seasonal employees of Payson Fruit Growers along with management and employees of all other local fruit processors participated in these training sessions.

May 2007 – Day One

- Food regulations, historical and social perspectives
- Management systems for food safety
- Developing and implementing a sanitation program
- Personal practices: GMP's Part 110.10
- Insect management in food plants
- Material control programs
- Food security overview

May 2007 – Day Two

- HACCP Discussions

1. History of HACCP
2. HACCP overview
3. SSOP's/prerequisite programs
4. Hazard's: Biological, Chemical, Physical

- HACCP Workshop: A step-by-step process to implement a food safety system. Seminar participants will develop a model HACCP program based on the seven principles of ASCCP with the guidance of the AIB staff.

Results, conclusions and lessons learned: The training conducted by both AIB and Oceana was essential and valuable for all attendees. Many aspects of the training were new and have since proven valuable in providing an excellent product and insuring to our customers that we have in place policies and practices that insure a safe, nutritious and protected food supply.

Long-term outcome measures: The seminars and inspections provided instruction that has since been passed on to the employees of the fruit industry. Subject matter such as personal hygiene, proper techniques in food handling, importance of Certificate of Analysis, proper unloading procedures, etc. have been stressed in management and employee meetings. Payson Fruit Growers has noticed an increased level of awareness and understanding of the importance of these and other polices and procedures.

Additional information: Information on AIB can be obtained on their website https://www.aibonline.org/

Contact:
Mr. Chad Rowley
Manager - Payson Fruit Growers
801.465.9242
chad13@paysonfruitgrowers.com

F. Improving Orchard Irrigation

Outline of the issue, problem, interest or need for the project: The availability of good quality irrigation water is a continuing limitation in Utah fruit production. Managing the available water to maximize "crop per drop" is essential. Low cost methods are available for measuring soil water content, and computer models are also available that estimate evapotranspiration (ET, an approximation of crop water use) based on local weather data. However, the accuracy of these two approaches can be somewhat variable in the orchard environment, and as a result adoption of these technologies has been very limited. Further improvements are needed in the accuracy of these approaches, and additional experience is needed with the use of these technologies in commercial orchard blocks.

The specific goals of the project are (1) improve the accuracy of and accessibility to weather station data for providing crop water use estimates (evapotranspiration or ET), (2) to assist commercial orchard managers in gaining experience with soil moisture monitoring systems, and (3) to evaluate regulated deficit irrigation practices for tart cherry production.

Approach:

1. A network of 9 telephone-linked automated weather stations were previously deployed in commercial and research orchards in Utah. Data from these stations had been used for making integrated pest management decisions, but not for managing irrigation. To improve the accuracy of ET data, the existing orchard weather stations needed to be upgraded. Upgrades included replacing defective sensors, changing sensor placement, and updating communication devices to digital cell phone modems. To improve ET data availability, a central website was needed that could be automatically updated through the cell phone connections.
2. Soil moisture measurement equipment was purchased and deployed in orchard blocks of cooperating growers in order to provide the orchard managers with practical experience in using technology to properly schedule irrigation.
3. Regulated Deficit Irrigation (RDI) is the practice of inducing mild water stress during specific stages of crop development in order to save water and to induce a favorable growth response. RDI is widely used in wine grape production to reduce irrigation water requirements and to increase fruit soluble solids in the harvested grape, but the technology has never been tested in Utah's largest fruit crop, tart cherries. A replicated trial was established on a commercial orchard near Santaquin, Utah, to test the effects of RDI during stage III tart cherry growth (pit hardening to fruit harvest) on fruit quality, dry weight yields, and tree health (trunk injury). Small blocks of trees are to be maintained at five different irrigation levels during stage III fruit growth, and fruit from each treatment was harvested and tracked through processing.

Goals achieved:

1. USU research technician James Frisby has completed updating the communication system for the orchard weather station, and continues to replace and reposition sensors to best provide data for estimating ET. The USU Extension IT staff implemented protocols for retrieving data from the weather stations and posting updates to a new web page.
2. A number of Watermark brand granular matrix sensors were purchased and deployed in commercial irrigation blocks, and instructions were provided on monitoring these sensors. In one location, the Watermark blocks were not suitable, and the cooperating grower switched to using the more expensive Diviner (Sentek) soil capacitance probe for monitoring soil moisture. Presentations were made at the USHA annual meeting and to informal orchard manager meetings to provide training on the use of ET estimates and soil moisture measurements for improved orchard irrigation scheduling.
3. USU graduate student Kylara Papenfuss maintained the RDI study through 2007, establishing orchard irrigation levels, tracking tree water status, and evaluating treatment effects on fruit quality and yield.

Results, conclusions and lesson learned:

1 & 2. A new extension website is now online that provides automatically updated weather data and ET estimates for the various orchard weather station sites. A series of Watermark sensors

and portable meters have been set up in cooperating orchard blocks and information has been distributed on the proper use of these technologies. One participating orchard manager reported that using the web-based ET estimates and the soil moisture monitoring equipment saved 12 days of irrigation in the spring of 2008. Water savings on this single farm amounted to 0.25 acre feet of water per acre of orchard. This reduced the water use of this one operation by 145 acre feet, with an additional savings of $2,400 in pumping costs. A neighboring farm that has not yet implemented these technologies but continued with a calendar-based irrigation schedule, is now struggling with unusually severe iron chlorosis in some fruit tree and berry crop blocks. This nutrient deficiency resulted in spite of an aggressive fertilizer program, and was the direct result of over irrigation in the spring.

Results from this work indicate that growers may be able to both reduce irrigation needs and improve tree health with the implementation of appropriate technology for measuring soil moisture, and tracking crop water use.

3. Regulated deficit irrigation treatments carried out in the summer of 2007 resulted in a 20% to 60% reduction in irrigation water use during June and July. Additional results are as follows:

- Among treatments, there was no difference in fresh weigh yields, and only a slight reduction in fruit size at the most severe deficits.
- Fruit soluble solids content (Brix) an indicator of processing quality, was highest in treatments that received the least water. The highest watering rate had fruit Brix of 13.1, compared to 14.7 for the lowest watering rate.
- There was relatively low incidence of trunk injury in the orchard in 2007. Only a few trees included in the experiment showed any visible trunk injury, so no conclusions can be made as to whether deficit irrigation affects susceptibility to trunk injury.
- Trees subjected to RDI in 2007 did not show any higher incidence of malformed flower buds, or any reduction in return bloom in 2008.

All of these results indicate beneficial effects of RDI, but should be considered preliminary as the treatments will need to be continued over multiple seasons to determine whether long-term RDI negatively impacts tree health.

<u>Long-term outcome measures:</u>

1. Infrastructure is now in place to provide timely ET estimates to commercial fruit producers in the state. We plan to continue to maintain and upgrade the weather station system, and to improve the web interface for accessing this information. One long-term goal of this will be to work with the Utah Climate Center to improve data accessibility, and potentially to integrate weather forecasts to anticipate crop water use.
2. Currently, the irrigation scheduling techniques that were the focus of this project have been fully implemented on only a handful of orchards. However, these early adopters have clearly demonstrated the benefits of the technology, and will continue to serve as demonstration sites for neighboring farms.
3. Initial results from RDI on tart cherry are encouraging. Except for use in wine grapes, RDI has not been widely adapted to other fruit crops due to undesirable consequences in fruit

size and marketability. If our continued research indicates benefits to fruit quality with no harmful consequences on tree health, an outreach program will be developed to assist growers in implementing this technology.

The UDAF-funded portion of this project provided the basis for obtaining continued funding through the Natural Resource Conservation Service (NRCS) Conservation Innovation Grant program (CIG). The CIG funding was matched by funds from the USHA research committee and by in-kind contributions from members of Payson Fruit Growers. This funding will allow the project to continue through 2010. Progress reports on this research have been presented to NRCS field staff and state level administrators during in-service training and executive meetings. Results from this work have also been the basis for changes to the NRCS Environmental Quality Incentives Program (EQIP) that provides incentives to growers to implement best management practices.

Additional information:

1. ET estimates from orchard weather stations are available online at http://extension.usu.edu/agweather/. A drop down menu for eight of the orchard weather stations can be found on the lower left corner of this web page.
2. Fact sheets providing specific information on orchard irrigation are available online for apple, peach, cherry and cane fruit at http://extension.usu.edu/publications. These are available on the "Fruit" page listed under the "Horticulture" heading.

Apple: extension.usu.edu/files/publications/publication/Horticulture_Fruit_2008-01pr.pdf
Peach: extension.usu.edu/files/publications/publication/Horticulture_Fruit_2008-02pr.pdf
Cherry: extension.usu.edu/files/publications/publication/Horticulture_Fruit_2008-03pr.pdf
Berries: extension.usu.edu/files/publications/publication/Horticulture_Fruit_2008-04pr.pdf

Contact:

Mr. Chad Rowley, Research Committee Chair, Utah State Horticulture Association.
559 East 610 South, Santaquin, Utah 84655

Dr. Brent Black, Extension Fruit Specialist, Utah State University
4820 Old Main Hill, Logan, Utah 84322-4820

G. Codling Moth Monitoring (A) and Cherry Fruit Fly Trapping (B)

Outline of the issue, problem, interest, or need for the project: (A) Apple growers utilize pheromone mating disruption to lower codling moth populations and allow integration of lower toxicity insecticides into their pest management programs. Monitoring codling moth adult densities is essential to evaluating the success of mating disruption and insecticide treatments. More information is needed on the attractiveness of commercially available codling moth lures in orchards with mating disruption. Development of useful trap thresholds and predictive relationships for fruit injury will empower Utah apple producers to effectively implement mating disruption of codling moth to their full advantage.

(B) The current trap design used to monitor western cherry fruit is only moderately attractive to adults. It primarily utilizes visual attraction, yellow color. The objective was to evaluate compounds that have been demonstrated as attractive to cherry fruit fly in laboratory and field experiments. Insecticide-baits such as GF-120™ are an alternative to more highly toxic, broad-spectrum insecticide cover sprays for fruit fly control. The current bait in the product is not highly attractive to eastern and western cherry fruit fly adults. Fruit fly attract-and-kill products would be more effective if the droplets were more attractive to cherry fruit fly adults rather than relying on chance encounters during foraging bouts in the tree canopies.

Approach: (A) Four types of codling moth lures were evaluated in 12 apple orchards: 1X, 10X, DA, and DA - Combo. Test lures were placed individually in large Delta traps. Each lure was replicated three times in a randomized block design in each orchard for a total of 144 traps across the 12 orchards (36 replicate traps with each lure). Traps were placed in orchards in early May and checked weekly through mid July and then every one to four weeks until September 19. Following completion of the first and second generations of codling moth egg hatch, 400 fruit were visually inspected in each orchard for surface stings and larval entries. Fruit with deep stings and suspect larval entries were cut open to verify the type of injury. The percentage of fruit with stings and entries was determined.

(B) Apple growers utilize pheromone mating disruption to lower codling moth populations. To compare the attraction of thirteen compounds to western cherry fruit fly adults when added to yellow sticky traps, experiments were conducted in five 'Montmorency' tart cherry orchards from first adult activity (mid May) through post-harvest (mid August). The treatments were: 1) ammonium acetate (AA), 2) ammonium carbonate (AC), 3) ammonium hydroxide (AH), 4) urea (U), 5) sweet cherry essence (SWCE), 6) sour cherry essence (SOCE), 7) single strength cherry juice (20-25 brix) (SSCJ), 8) concentrate cherry juice (65 brix) (CCJ), 9) torula yeast (TY), 10) brewer's yeast (BY), 11) molasses (M), 12) sucrose (S), and 13) no bait (NB).

Goals achieved: By following statistically rigorous experimental designs, valid comparison of codling moth pheromone lures and cherry fruit fly adult attractants were accomplished.

Results, conclusions and lesson learned: (A) Combo-baited traps caught the most moths in all orchards and tracked codling moth generation cycles and peaks the best in combination with a degree-day model. The ability to predict fruit injury from trap catch was the best for both DA and Combo lures. There was a relationship of an increase of 0.2% fruit injury for every moth caught in a DA- or Combo-baited trap.

(B) Ammonium carbonate (AC) and ammonium hydroxide (AH) were attractive to western cherry fruit fly adults. On most dates, AH and AC increased adult capture by about ten times over non-baited traps. Brewer's yeast (BY) also enhanced attraction of fruit flies over non-baited traps and some of the other treatments on some dates. None of the adult attractants enhanced the performance of GF-120™ over use of the bait-insecticide product alone. The extremely high fruit fly population in this study site may have precluded the ability of any bait product to prevent fruit injury. The ten times reduction in fruit injury from untreated to GF-120 treated plots observed in this trial may translate to prevention of detectable injury in typical commercial cherry orchards.

Long-term outcome measures: Improvements to codling moth and cherry fruit fly monitoring technologies will be made based on results from these and other research trials.

Additional information: **Publications and Web Sites:**

Extension Fact Sheets:

Alston, D., M. Murray, and M. Reding. 2006. Codling moth (*Cydia pomonella*). Utah State University Extension Publication ENT-13-06. http://extension.usu.edu/files/publications/factsheet/codling-moths06.pdf.

Alston, D., M. Murray, M. Reding, and C. Miller. 2006. Western cherry fruit fly (*Rhagoletis indifferens*). Utah State University Extension Publication ENT-102-06. http://extension.usu.edu/files/publications/factsheet/western-cherry-fruit-flies06.pdf.

Web Sites:

Utah Pests (UTAH PESTS is your portal for learning more about pests and their beneficial counterparts, and how Utah Extension personnel are working to provide a greater understanding of these organisms in our world): http://utahpests.usu.edu/.

Utah Integrated Pest Management (IPM is a strategic approach to plant and animal care that seeks to suppress pest populations while minimizing pest control costs and environmental disruption. IPM attempts to integrate numerous control tactics, such as cultural, mechanical, biological and chemical methods): http://utahpests.usu.edu/ipm/.

Contacts:

Dr. Diane G. Alston Entomologist Department of Biology Utah State University Logan, UT 84322-5305 435-797-2516 diane.alston@usu.edu		Mr. Chad Rowley Chairman – Utah State Horticultural Research Committee 801.465.9242 chadr13@comcast.net

H. Survey of Erwinia amylovora (Ea) Bacterial Isolates (Fire Blight)

Outline of the issue, problem, interest, or need for the project: Fire blight remains the most serious disease affecting apple production in Utah and in apple orchards worldwide. After many years of reliance and overuse of streptomycin, resistance to this antibiotic is widely reported but was only reported in recent years in Utah (Jones and Shnabel, 2000, Thomson and Ockey, 2001). Our first objective in this survey and series of experiments was to determine the frequency and degree of streptomycin resistance in commercial apple orchards in Utah. Our second objective was to investigate the use of kasugamycin (Kasumin, Arysta Life Sciences), compared to other agricultural antibiotics commonly used in the U.S.A., to control both shoot and floral strikes of fire blight caused by *Erwinia amylovora* (*Ea*), the causal pathogen of fire blight.

Approach: Three Different studies were performed, Ea Survey, Shoot Strike Study and Floral Strike Study.

Goals achieved:

Ea Survey: Over 300 *Ea*-suspect samples were collected from apple orchards in Utah, Box Elder, and Cache counties in the state of Utah in 2006, over 500 *Ea*-suspect samples were collected from Utah County in 2007. Samples were processed in the laboratory by culturing in nutrient broth for 24-h at 30° C.

Shoot Strike Study 2006, 2007: Four apple cultivars inoculated in 2006 were 'Gala', 'Ida Red', 'Jonathan', and 'Dixie Red'. In 2007 'Prime Gold' was substituted for 'Jonathan' in the shoot strike study as the 'Jonathan' trees became systemically infected following the floral strike portion of the study.

Floral Strike Study 2007: Four apple cultivars were inoculated at flowering. The apple cultivars used were 'Gala', 'Ida Red', 'Jonathan', and 'Dixie Red'. The experimental design was the same as the shoot strike experiments except only 10 floral clusters per tree were inoculated.

Results, conclusions, and lessons learned:

2006 *Ea* Survey: There were 122 *Erwinia amylovora* single colony forming isolates made from infected apple tissues in 2006 (Fig. 1). Thirty-two (about 26% of the total collected) isolates of *Ea* were found to be resistant to commercial rates of strep (100 ppm). Resistant isolates were found at all commercial sites sampled (distribution appears random). Of the 32 isolates identified as resistant to streptomycin at 100 ppm, 18 of those were found to be resistant at 200 ppm and 14 were found to be resistant at 400 ppm. None of the isolates were resistant at 1000 pm streptomycin.

2007 *Ea* Survey: There were 345 single colony forming *Ea* isolates made from over 500 fire blight symptomatic apple samples in 2007 (Fig. 2). All samples were collected form apple and pear orchards in Utah County. Percentages of Ea isolates in the bacterial population that were found resistant to streptomycin was about 72% at 30 ppm, 65% at 100 ppm, and about 47% at 200 ppm and higher. Percentages of resistant *Ea* isolates in the population were virtually a constant proportion at 200 ppm and higher concentrations. None of these strep-resistant *Ea* isolates were resistant to oxytetracycline when cultured on 30 or 100 ppm amended nutrient agar medium. None of the isolates were resistant to kasugamycin at 100 ppm although a few (5 isolates) showed weak growth on nutrient agar medium amended with kasugamycin at 30 ppm. None of these 5 isolates were resistant to oxytetracycline at either 30 or 100 ppm concentration of nutrient agar amended medium.

2006-2007 Shoot Strike Experiment: In the two shoot strike experiments (Fig. 3), conducted in 2006 and 2007 to compare control of *Ea* shoot strikes using Kasugamycin (Kasumin) , streptomycin (Agrimycin), and oxytetracyline (Mycoshield), Kasumin was as effective or better than Agrimycin controlling shoot strikes in 2006. In 2007 Kasumin was equal to Agrimycin in two of four apple cultivars that were evaluated for fire blight shoot strikes.

2007 Floral Strike Experiment: Significant differences (P=0.05) among antibiotic treatments were observed when averaged over four apple cultivars (Fig. 4). Floral fire blight strike percentages for water treated blossoms was 26.3 %, for Mycoshield at 100 ppm floral strike percentage was 14.5 %, for Kasumin at 100 ppm floral strike percentage was 8.6%, for Kasumin at 80 ppm floral strike percentage was 7.4%, and for Agrimycin at 100 ppm floral strike percentage was 5.0% (*l.s.d.*=2.0).

Long-term outcome measures:

Ea Surveys 2006 – 2007: It is clear that resistance to one antibiotic does not automatically mean resistance will be conferred to another antibiotic. For example: High levels of resistance to streptomycin were observed in 2007, a very severe year for fire blight in Utah apple orchards. However, none of the isolates that were resistant to streptomycin were found to be resistant to Kasagamycin (Kasumin) at 100 ppm in laboratory screening. It is also clear that rotation of antibiotics has been and will remain a critical strategy to maintain efficacious control of Ea in commercial apple or pear production orchards in Utah. Evidence suggests a strong need to obtain EPA labeling for use if Kasugamycin in commercial apple orchards in Utah.

Shoot Strike 2006-2007: Kasumin offers effective control of *Ea* shoot strike infection compared to streptomycin and oxytetracycline compounds. This was demonstrated in two consecutive years of field evaluations at the Kaysville, UT, experiment station (Fig. 3).

Floral Strike 2007: Kasumin is useful to control fire blight at flowering in apple orchards in Utah. *Ea* isolates resistant to streptomycin have not shown resistance to Kasumin in laboratory tests to date. Also, we continue to see that no resistance is found to oxytetrcycline. However, Kasumin would relieve some pressure on orchards where streptomycin resistance is known to occur and perhaps alleviate the concern of possible development of resistance to oxytetracycline as it is the only agricultural antibiotic used in Utah apple orchards where streptomycin resistance is known to occur.

Results of the Erwinia amylovora survey were presented in Portland, Oregon to participants of the 11th International Fire Blight Meetings, August 12-17, 2007. The information was presented in a poster format. The results were also submitted, in written format, to the Acta Horticulturae journal and were accepted for publication but are "in press" at present. Acta Horticulturae is an international journal of published proceedings of scientific society's meetings. The results of the Erwinia amylovora survey were also presented at the annual meeting of the Utah State Horticulture Association, January 22, 2008. There were 60 persons attending that session. The data were also generally presented in an updated Fire Blight fact sheet that can be viewed at: https://extension.usu.edu/file/publications/factsheet/fire-blight-08.pdf. The link to the fact sheet was published in the Utah Pests quarterly newsletter and is available to the general public of Utah. General recommendations, based on the survey findings of resistance to streptomycin, are for the public and commercial growers in Utah County to avoid using streptomycin antibiotic compounds to control fire blight; it has proven to be insufficient to control fire blight there.

Additional information: Sincere thanks are extended to the Utah State Horticultural Association, the Utah Agricultural Experiment Station, Utah State University, and the Utah Department of Agriculture and Food Specialty Grant program for funding support.

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Jones, A. L., and Schnabel, E. L. 2000. The development of streptomycin-resistant strains of *Erwinia amylovora*. In: Fire Blight: the disease and its causative agent *Erwinia amylovora*. (ed.) J. L. Vanneste, CABI Publishing, New York.

Thomson, S. V., and Ockey, S. C. 2001. Sudden widespread appearance of streptomycin resistance in *Erwinia amylovora* in Utah. Phytopathol. 91:S88.

Evans, C.K., 2008. Survey results of *Erwinia amylovora* in Utah for resistance to streptomycin and investigations comparing Kasugamycin (kasumin) to streptomycin and oxytetracycline for control of fire blight. Acta Hort. (ISHS) 793:433-437, http://www.actahort.org/books/793/793_66.htm.

Contact:

C. Kent Evans
Utah State University – Biology Department
5305 Old Main Hill
Logan, UT 84322-5305

Mr. Chad Rowley
Chairman – Utah State Horticultural Research Committee
801.465.9242
chadr13@comcast.net

I. Evaluating the Native Shrub Eriogonum corymbosum as a Nursery Crop and for use in Low Water Use Utah Landscapes

Outline of the issue, problem, interest, or need for the project: Low water landscaping is a critical tool for water agencies and policy makers throughout Utah who are balancing limited water supplies against increasing demand from population growth. Low water landscaping is key to sustainable, long term water savings because it inherently changes behavior. Drought tolerant plants are essential to successful low water use landscaping. In particular, Utah native shrubs and wildflowers offer a tremendously valuable and diverse palette of attractive drought tolerant plants that are adapted to our arid climate.

The genus *Eriogonum* has many species native to Utah that are both attractive and drought-tolerant. *Eriogonum corymbosum* in particular is a shrubby species that is especially promising. It is found throughout southern Utah in dry habitats and, unlike almost all other native shrub and perennial wildflower species, it blooms the first year from seed. It also blooms during late summer-early autumn when little else is in flower, and is highly diverse genetically. The flowers of *E. corymbosum* vary from white, to cream, yellow, pink and red. Its crown form also varies between very regular hemispheres to a more irregular open shape of different sizes, and its leaves vary in both size and color.

The diverse ornamental characteristics of *E. corymbosum* suggest the opportunity for a number of economically valuable cultivars However, the genetic stability of this variation in ornamental traits is unknown. If these traits are not reproducible from seed, there is little prospect for cultivar development. Also, while *E. corymbosum* is found in dry habitats, how much drought it can tolerate in the landscape, while maintaining appearance and growth, is not known. Understanding the genetic stability of its ornamental traits and its drought tolerance is critical to the economic acceptance of *E. corymbosum* by the nursery industry and the plant-buying public.

Approach: Collecting *E. corymbosum* accessions that represented the range in variation in the visual characteristics of the species throughout the state of Utah.

- Plant the different accessions in a common garden and evaluate the range in characteristics under uniform conditions. Then bagging some flowers of each plant to ensure that they are crossed only with themselves. Collect seed from open pollinated flowers and from bagged flowers, then evaluate the offspring of each accession to determine the degree each type of seed, outcrossed versus non-outcrossed, represent parental morphological traits.
- Four selected accessions that represent the range in morphological characteristics will be planted in a field experiment. In addition, along with planting a non drought tolerant conventional landscape species, all species will be irrigated at different frequencies over the season. Impact of drought will be measured in terms of internal water potential, stomatal conductance (photosynthesis), above ground growth, and plant mortality.

Goals achieved:

- Fifteen accessions representing a range of *E. corymbosum* habitats were collected in 2005 and 2006.
- The 15 accessions were germinated in spring 2006 and allowed to establish in small containers then planted in a common garden, five plants per species, in spring 2007 and allowed to establish the rest of the season.
- The field experiment was established in 2007 with four accessions and with *Cornus sericea* planted as the non drought tolerant control.

Results, conclusions, and lessons learned: The year 2007 to June 2008 the project was in establishment phase, and the main data collection will commence in 2008-2009. Several accessions have proven to be very sensitive to any kind of water. Interestingly, these accessions all had yellow flowers, suggesting that those types simply may not lend themselves to nursery production. For the irrigation experiment, we originally proposed a line source study with overhead irrigation, but variability due to wind proved too great, and we have shifted to a more conventional drip irrigation study with three treatments: no irrigation, irrigation once a week, and irrigation every six weeks.

Long-term outcome measures: 2007 was an establishment year that has both the irrigation and the common garden study poised for detailed data collection in 2008-2009. In summer 2008, complete morphological description of each of the surviving plants in each accessions will be made. Flowers on each plant will be bagged, and in October 2008 seed collected from bagged

and non-bagged plants. The seed from each treatment will be stratified in December and plants germinated in February 2009, and the morphology of the two types of offspring will be described in summer 2009.

2007 was also an establishment year in the irrigation study. In mid July 2008, the three irrigation treatments will be applied, no irrigation, weekly irrigation, irrigation every three weeks. The treatments will be applied identically in summer 2009. Stomatal conductance and water potential will be measured weekly, and overall plant size will be measured at the end of the study in 2009.

Additional information: None yet

Contact: Roger Kjelgren, Dept. Plants, Soils, and Climate, Utah State University, Logan, UT 84322, rkjel@usu.edu, 435-797-2972.

Appendix A. List of *Eriogonum corymbosum* accessions.

#		H/W ft	Canopy	Flower color	Leaf size cm.	Leaf shape	Longitude	Latitude	Elevation ft.
1	Long Canyon	3x5	open	white	2x2	roundish	N 37° 51' 10"	W 111° 18' 45"	5685
2	Escalante	1.5x3	hemisph.	white/red	1x.75	roundish	N 37° 48' 49"	W 111° 26' 32"	5974
3	East Zion	3x5	open	peach	1.5x2	roundish	N 37°15' 43"	W 112° 47' 7"	5973
4	Moab	3x6	hemisph.	white	3x2	roundish	N38° 40'55"	W109°28'40"	4034
5	Hanksville	3x5	hemisph.	white	3x1.5	elliptical	N38°00' 03"	W110°30' 46"	4642
6	San Rafael Swell	3.5x5	hemisph.	pinkish	2x.75	linear	N38°54' 02"	W110°36' 16"	6678
7	San Raphael Swell	4x4	open	reddish	2x.75	linear	N 39°04'49"	W110°40'02"	5104
8	Goblin Valley	3x5	hemisph.	yel/red	5x1	linear	N38°36' 22"	W110°41' 12"	5037
9	San Rafael Swell	1.5x3	hemisph.	pinkish	2x.75	linear	N39°09' 39"	W110°43' 46"	5522
10	West Escalante	3x5	hemisph.	pinkish	3x1	linear	N 37° 36' 60"	W111° 55' 00"	6543
11	Cedar Canyon	2x4	open	yellow	2.5x1.5	elliptical	N 37° 38' 4"	W112° 56' 42"	7084
12	Henryville	3x5	open	yellow	2.5x1.5	elliptical	N37°33'50"	W112°02'15"	5988
11	Tropic	2x4	open	reddish	2.5x1	linear	N37° 37'12'	W112°4' 40'	6281
13	Springdale	3x5	hemisph.	white	3x1	linear	N37°11'48"	W112°59'34"	3930
14	Shivwits	2x4	open	Yel/white	2.5x1	elliptical	N 37° 10' 56"	W113° 46' 10"	3300
15	Rockville	2x4	open	white	N/A	N/A	N37°09' 41"	W113°01' 54"	N/A

Appendix B. Pictures of the range of visual characteristics of *Eriogonum corymbosum*. Small and large *Eriogonum corymbosum* (left), and variation in foliage color (right).

Appendix C. Pictures of irrigation study, 2007 (left), 2008 (right).

J. Utah's Native Flora

Outline of the issue, problem, interest or need for the project: Demand for regionally appropriate plant materials for arid, high desert climates, such as Utah, has increased throughout the Intermountain West. Consumer demand is fueled largely by concerns over water resources and the expectation that a burgeoning population will further diminish such a finite resource. As a result, numerous cities throughout Utah are adopting water conservation measures. Landscape ordinances that specify native plant materials have become a major component of these water conservation strategies. Unfortunately, however, market demand continues to exceed plant availability, due in part, to insufficient quantities of seed and reliable propagation and cultural techniques available to growers of native plant species.

The scope of the project identified nine Intermountain native plants that exhibited desirable characteristics, such as size, flower color, and adaptability to a wide range of urban landscapes. We set out to increase seed availability by planting seed production blocks, developing efficient propagation techniques and cultural methodologies, and conducting plant evaluations to ascertain aesthetic and functional traits such as consumer appeal and adaptability to urban environments.

The State of Utah is home to nearly 3,000 plant species, ranking eighth nationally in biodiversity. A random survey of plant availability lists of Utah native plant producers in 2007 revealed that not even 100 species comprised the total available product mix. Horticultural development of additional native plants has the potential to economically stimulate and strengthen the horticulture trade in the State of Utah by simply providing opportunities for entrepreneurs to expand into new markets such as seed collection, seed increase, plug production, finished crops, as well as landscapes renovations for the purpose of water conservation and aesthetic.

Approach: In order to meet the project goal of transferring new knowledge and technology to seed and green industry professionals, five objectives were identified that would embolden the economic vitality and sustainability of the industry and broaden the plant palette available to Utah consumers. The five objectives were:

1. Conduct statewide plant population surveys and mapping in order to identify plant species that exhibit potentially superior aesthetic characteristics.
2. Wildland collection of native plant species.
3. Investigate and develop plant propagation techniques.
4. Establish stock seed production plots.
5. Establish common garden and landscape demonstration plots.

Goals achieved (combined with) Results, conclusions and lessons learned: In accordance with Objective One, nine accessions, which exhibited aesthetically superior traits, were identified and mapped in June of 2007. These accessions included two of *Bouteloua gracilis* (Blue grama), and one each of the following species; *Epilobium canum* ssp. *garrettii* (Firechalice), *Fallugia paradoxa* (Apache plume), *Fraxinus anomala* (Singleleaf ash), *Helianthella uniflora* (One-head sunflower), *Heliomeris multiflora* (Showy goldeneye), *Iliamna rivularis* (Streambank hollyhock), *Leymus cinereus* (Basin wildrye), and three accessions of *Rhus glabra* var. *cismontana* (Western smooth sumac). In total, twelve accessions were collected (Box Elder,

Cache, Emery, Salt Lake, Wayne, Weber counties and in extreme southeastern Oneida County, Idaho) that either exhibited marketable traits or lacked adequate representation in the nursery trade.

From August to October 2007, propagative material (seed, cuttings) was collected in order to facilitate germination tests, develop container production protocols, and produce seedlings for either establishment of seed increase blocks or common garden and landscape demonstration plots.

Propagation strategies for all nine species have been developed and establishment of container seedlings have been completed in accordance with Objective Three. Cultural methods have been analyzed using specialized containers, fertilizer rates and supplemental lighting to enhance plant growth rates, maximize asexual production of cuttings, and stimulate flower initiation.

For many years, nursery professionals throughout Utah interested in growing and selling native plants have worked in isolation, marginalized within their own industry, and without adequate resources to promote their cause. Resources, such as a consistent supply of quality seed, have been unavailable to these growers. Factors that influence seed quality and availability are many, and include, poor seed set, insect and rodent damage, seed shatter, and site inaccessibility. In order to address these issues, stock seed/cutting production plots of all twelve accessions identified in Objective One have been planted at the Utah Botanical Center .Of those accessions, nine will produce seed or cuttings in the fall of 2008. The remaining three accessions will begin to produce seed or root cuttings in 2009. The result of the project will support both seed and nursery industries by insuring that seed and propagules are available to farmers, ranchers, and nurseries. The selection of *Epilobium canum* ssp. *garrettii* 'Mountain Flame' is due for release in 2009 to nurseries and garden centers and the selection of *Leymus cinereus* is hoped to follow shortly thereafter.

The result of moving native plant species into the urban landscape is not adequately observed or reported. Research into this area is particularly needful in order to ascertain the true benefits of native plants in cultivated landscapes. In a 2006 survey conducted by Megan Guenter, a graduate student at Utah State University, fifty-two percent of the nursery professionals reported that they were not familiar with how to care for native plants in a home landscape. It is reasonable to say that the percentage of homeowners who do not understand native plants is much higher. Objective Five is an attempt to understand the growth habits and requirements of native plants in a constructed landscape. This was accomplished by establishing demonstration gardens using all nine species identified in this project. Improved information about plant-water relationships, proper plant placement, design concepts, and how to establish and maintain a native plant landscape are forthcoming as each species matures and develops.

Long-term outcome measures: This project set out to increase the availability of quality seed, expand the palette of native plants available to growers, develop new and/or improved plant production protocols, make recommendations of plant habit and growth characteristics in a landscape setting, and introduce tested plant materials to the market. With the goals and objectives met to date, it appears long-term outcomes will be excellent.

Species	Seed/ Propagule Availability	Production Protocol	Landscape Recommendation	Target Trade Introduction
Bouteloua gracilis 'Red Rain Germplasm'	2008 seed	X	X	
Bouteloua gracilis 'Dixie Germplasm'	2008 seed	X	X	
Epilobium canum ssp. *garrettii* 'Mountain Flame'	2008 propagule	X	X	2009
Fallugia paradoxa 'Avalanche Germplasm'	2008 seed	X	X	
Fraxinus anomola 'Buckhorn Wash Germplasm'	2008 seed	X	2009	
Helianthella uniflora	2008 seed	X	2009	

Additional information: Chart 1 demonstrates the current status of each of the plant accessions at the time of this report. Data accumulation and analysis will continue until October 2009 at which time a complete measure of the results can be tallied.

Heliomeris multiflora 'Eden Germplasm	2008 seed	X	2009	
Iliamna rivularis 'Fremont Germplasm'	2008 seed	X	X	
Leymus cinereus 'Big Blue Germplasm'	2009 propagule	X	X	2009
Rhus glabra 'Cherry Creek Germplasm'	2009 propagule	X	X	
Rhus glabra 'Cistern Germplasm'	2009 propagule	X	X	
Rhus glabra 'Segundo Germplasm'	2009 propagule	X	X	

Chart 1: Work performed on each species. According to the project work scope, additional and replicative germination techniques will be performed on accessions prior to publishing propagation protocols, observational data will be collected in demonstration landscapes to determine best management practices, and eventual release of accessions to the horticultural trade based on common garden results.

Appendix 1

Species and Collection Locations

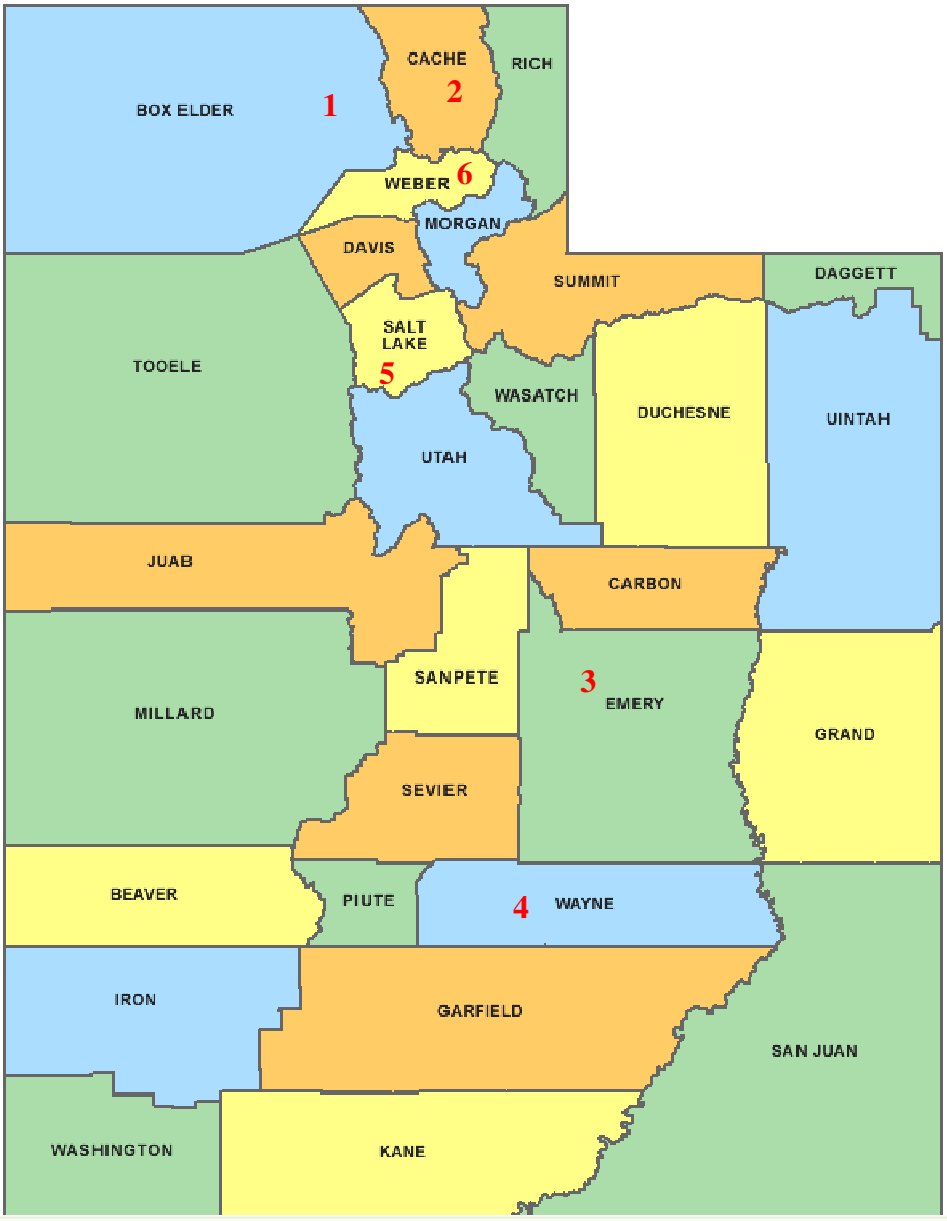

Figure 1: Map of Utah counties demonstrates the approximate location of collection sites and species collected. Site 1 *Rhus glabra* var. *cismonatana* (Cistern and Segundo Germplasms). Site 2 *Helianthella uniflora*. Site 3 *Fallugia paradoxa*, *Fraxinus anomola*. Site 4 *Bouteloua gracilis* (Red Rain and Dixie Germplasms). Site 5 *Epilobium canum* ssp. *garrettii*. Site 6 *Heliomeris multiflora*.

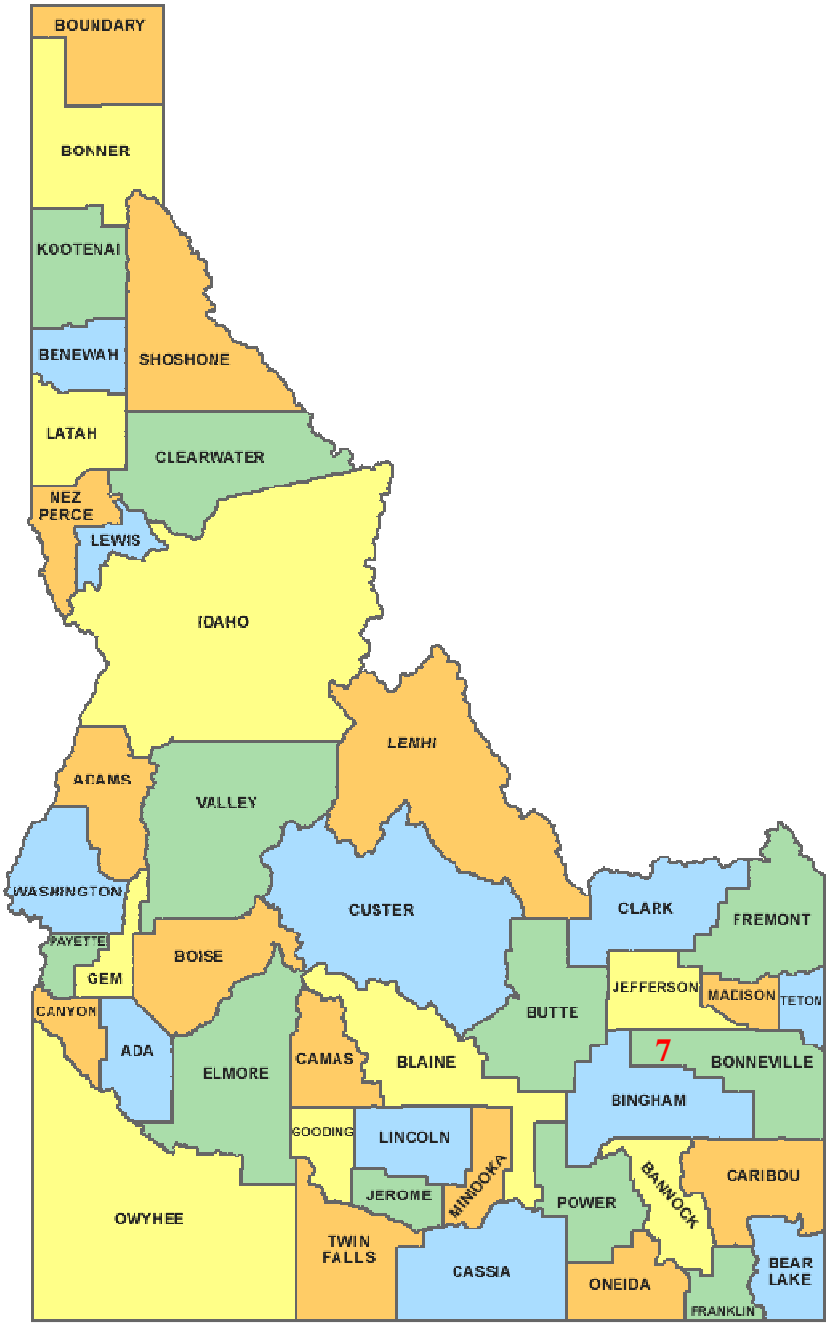

Figure 2: Map of Idaho displays the approximate location of collection site and species collected in Oneida County. Site 7 *Rhus glabra* var. *cismontana* (Cherry Creek Germplasm), and *Iliamna rivularis*.

Contact:

William A. Varga and Richard M. Anderson
Utah Botanical Center, Utah State University
725 South Sego Lily Drive
Kaysville, UT 84037
801-593-8969

Stanford A. Young and Michael Bouck
Utah Crop Improvement Association, Utah State University
4855 Old Main Hill
Logan, UT 84322-4855
435-797-2082